

Microbiological Quality: Understanding Drinking Water Quality and Management

Microbial quality is one of the primary indicators for the safety of a drinking water supply. Of all contaminants in drinking water, human and/or animal faeces present the greatest danger to public health. Pathogenic or disease causing microorganisms (including certain protozoa, bacteria or viruses) may be found in untreated water supplies. Bacteriological monitoring or testing is a way to detect and thereby control pathogenic bacteria in treated drinking water supplies.

The presence of waterborne disease causing microorganisms in drinking water may result in gastrointestinal illness or diarrhea. Infants, the elderly and immuno-suppressed individuals are at greater risk of serious infection when exposed to these organisms. If left untreated, a healthy person is usually free from symptoms in less than a month. There are anti-parasitic drugs that will assist in a quicker recovery.

How To Determine The Microbiological Quality

Coliform bacteria are a group of bacterial organisms used as **indicators** to help determine if treated water is of a microbial quality acceptable for human consumption. Since specific disease causing organisms are difficult to detect, the microbial quality is determined indirectly through counts of these indicator organisms. The presence of coliform bacteria suggests that disease-causing bacteria may also be present but these indicators cannot serve as a direct way of measuring the presence of pathogens. The presence of total coliforms in drinking water indicates treatment is inadequate or the distribution system may be experiencing re-growth or infiltration.

Contained within the total coliform group of organisms is a sub-group known as fecal coliform bacteria. These are typically found in the intestines of warm-blooded animals. If fecal coliforms are detected in drinking water, contamination by sewage or other sources of fecal matter is a possible cause. Certain types of fecal coliforms can be found naturally on vegetation and in soils. *E. coli* (*Escherichia coli*) bacteria are also be found in the intestinal tract of warm blooded animals and are included in the fecal coliform group. *E. coli* are a definite indicator of the presence of fecal material and inadequate treatment. Improper techniques used to collect samples can and often does cause false test results.

The Guidelines for Canadian Drinking Water Quality lists the standards for microbial quality in drinking water. The maximum acceptable concentration for bacteria is zero organisms detectable per 100 mL of water.



to provide
by chlorination, or by
other suitable approved
means, of the water
entering a distribution
system and throughout
the distribution system.



Monitoring Requirements For Microbiological Quality

The monitoring requirements for a particular community depend upon population, nature of the supply, susceptibility to bacterial contamination and historical bacteriological results. The minimum monitoring requirements are as below: (In some cases, municipalities may be required to monitor more frequently.)

Population	Groundwater Source	Surface Water and Blended Source
0-100	1 per 4 weeks	1 per 2 weeks
101-500	1 per 2 weeks	1 per week
501-5,000	1 per week	1 per week
5,001-100,000	1 per 2,000 pop. per 4 weeks	1 per 1,000 pop. per 4 weeks
>100,000	1 per 4,000 pop. per 4 weeks	1 per 3,000 pop. per 4 weeks

Samples should be taken from representative locations throughout the distribution system. To assist public system owners to comply with the monitoring requirements, the required bacteriological samples may be submitted to the provincial laboratory and analyzed at no cost.

At present, the level of **free** chlorine in water entering the distribution system must be no less than 0.1 milligrams per liter (mg/L). Also, the level of total chlorine must be no less than 0.5 mg/L or the level of free chlorine must be no less than 0.1 mg/L throughout the distribution system.

Water Samples For Bacteriological Analysis

Regular samples are to be collected at various points throughout the distribution system.



Laboratory staff filtering water through membrane.

1. Locate a sample collection faucet not connected to a water treatment device (ie. water softener or water filter). Never sample from a hydrant, hose or outside faucet. Ensure there is no strainer on the faucet.
2. Wash your hands carefully and leave the faucet running.
3. After two to three minutes, perform free and total chlorine residual tests (and turbidity if required) and record the results. (Do not perform on site tests using the sample bottle contents.)
4. Reduce the flow to a steady stream.
5. Take the cap off the sample bottle and hold the bottle in one hand; the bottle cap in the other hand. Do not lay the cap down, drop it or touch the inside of the cap or jar. If you do, use a new bottle.
6. Never rinse the bottle. Carefully fill the bottle to the top of the label without splashing. Place cap on the bottle and turn off water.
7. Fill in the sampling form, including the on-site test results.
8. Mail immediately to the Provincial Laboratories in the supplied container. Sampling should be conducted at a time when samples will arrive at the laboratory by Thursday of the week.

How Tests Are Conducted To Determine Total Coliform Bacteria

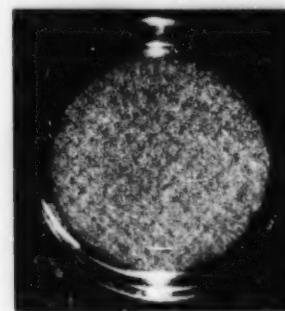
One of the commonly used methods is known as Membrane Filtration. This provides a count of bacteria per specific volume of a drinking water sample. This test involves taking a specific volume of the sample (usually 100 millilitres) and filtering it through a sterilized filter membrane. The pore size of the membrane is 0.45 μm (microns) so it is small enough to collect any bacteria that may be present. The filter is placed into a petri dish containing an appropriate growth medium (nutrient agar) to assist bacteria growth. The dish needs to be incubated at a temperature of approximately 35° celsius for 22 to 24 hours.



Preparing membrane filter assembly.



Placing filter on petri dish.

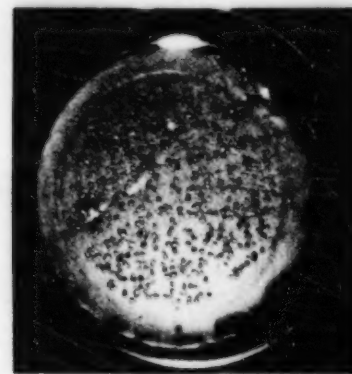
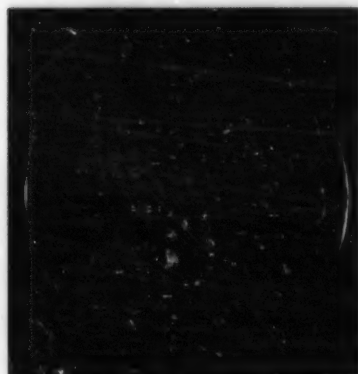


Petri dish ready for incubation.

The filter is then inspected for bacterial growth. If total coliform bacteria are present it will be evident by shiny green dots (bacterial colonies), which may have to be observed under a microscope. (See below.)

There are some drawbacks to this method. The nutrient agar growth medium is not specific for total coliform. Other bacteria may also grow on it and may result in an overgrowth appearing as a mass of material that hides indicators of total coliforms. (See below.)

If there is not an overgrowth but additional growth is present, these other bacteria may appear as a red, pink or colorless mass and are called background bacteria. This may indicate a treatment problem (ie. insufficient disinfection) at the facility. (See below.)



Generally, drinking water is safe when testing shows the absence of bacterial contamination. While the absence of indicator organisms denotes the absence of enteric (intestinal) bacteria, it is not a complete guarantee enteric viruses and protozoa (such as giardia and cryptosporidium) are absent. This is why it is important a multi-barrier approach be used to manage drinking water quality. This includes source protection, use of appropriate treatment, proper operation and maintenance of the distribution system and routine monitoring of drinking water quality.

Potential problems that will affect the outcome of the testing procedure:

1. High turbidity in a sample will limit the amount of water passing through the filter in a reasonable time. When only 50 millilitres is filtered, the result is reported as two times the count per 100 millilitres.
2. A highly turbid sample may affect the growth of bacteria by not allowing it to contact the nutrient agar providing misleading results.
3. A highly turbid sample may also be mistaken as background bacteria providing incorrect results.
4. Background bacteria growth may mask the presence or inhibit the growth of total coliform bacteria and will make the results misleading.



Effective Treatment Techniques/Processes To Protect Drinking Water

A number of processes are available to inactivate and/or remove pathogens from drinking water. Every effort should be made to select a raw water source relatively free from microbial contamination. The multi-barrier approach will provide additional protection and may reduce the level of treatment required. The minimum treatment required for a water supply derived from a surface water source or a ground water source directly affected by surface water includes coagulation, sedimentation, filtration and disinfection. For a water supply obtained from groundwater without affect from surface water, the minimum treatment includes disinfection. Additional processes may be required for water supplies which contain high levels of constituents (such as iron and manganese) that may impact disinfection processes.

Sample returned from the laboratory with an unsafe result

In the case of a positive bacteriological sample, the owner and operator of the waterworks will be notified immediately. Depending on the type of bacterial contamination found in the water sample, additional follow-up sampling and precautionary measures may need to be implemented.

In the event that total coliform bacteria are found, following notification of the owner, Saskatchewan Environment will recommend corrective actions and a series of repeat samples will need to be collected and submitted for analysis. Depending on the outcome of recommended corrective actions and re-sampling, the department may issue a Precautionary Drinking Water Advisory (PDWA) if the cause of the total coliform contamination cannot be determined and resolved.

If initial laboratory sample results indicate the presence of fecal coliform bacteria including *E. coli*, similar follow-up investigation and sampling will be necessary. Since the presence of these organisms indicate fecal contamination exists and treatment may not be fully effective, an Emergency Boil Water Order (EBWO) may be issued by the local Medical Health Officer as a way to protect the consumers from adverse health impacts.

Saskatchewan Environment will assist in determining and resolving the problem to support our commitment to ensuring the safety of drinking water in Saskatchewan communities.

For more information, contact:

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